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A Study On Computer Based Monitoring SystemFor Hazardous Area Safety Measurement UsingVirtual Instrumentation

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Abstract- *Today there is a great challenge in the development of industrial hazardous safety monitoring for the application of gas leaks, fire, smoke, radiation etc. In all related fields of investigation, a key matter is the need flexible and practical virtual instruments, a way to easily expose the multi-sensors to the hazardous levels in risk concentration. The implementation of wireless sensor network provides an alternative solution by deploying a larger number of disposable sensor nodes. The Sensor data may consist of industrial environmental parameters like critical temperature, gas leakage, radiation, fire, smoke and the dynamic variations of these physical quantities. This software platform is in the terms of virtual instruments developed under Lab VIEW programming environment and integrated with computer controlled system.*

Keywords: computer control, hazardous environment, Lab VIEW, virtual instrumentation, wireless sensor network.

I INTRODUCTION

Industrial safety is one of the major issues in hazardous environment, specially industries like fireworks, chemical, foundry and manufacturing etc. In hazardous environment, safety is a very important factor. To avoid any types of unwanted phenomena all hazardous area follows some basic preventative measure and phenomena. Communication is the factor for any industry today to monitor different parameters and take necessary actions accordingly to avoid any type of hazards. To avoid health injury and material loss, protection system as well as faithful communication system is necessary inside and outside the industry. To increase both safety and productivity, a reliable communication must be established between workers and a fixed base station. The wired communication system is not effective. The reliability and long life of conventional communications systems in harsh hazardous environments has always been a problem. Inside the industry due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. It is very difficult to install the wired communication system it again inside industry after a landslide or damage due to some reason. Due to maintenance activity, if by any means some workers trapped, to maintain the continuity of the communication system is very much important to know the actual position and condition of the trapped workers. To monitor multi parameters during this condition it is very much necessary to maintain the communication system as usual. Accordingly, development of safety monitoring system to accurately detect temperature, radiation, flammable and poisonous gas and fire and smoke on real-time has significant meaning to safety and rescue of disaster.

Hazardous area safety monitoring system based on wireless sensor network can effectively and accurately reflect dynamic situation monitored with help of computer based virtual instrumentation techniques .So, wireless communication is the essentially need today for the fast, accurate, flexible safety monitoring and control process in hazardous environment.

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There are different other research ideas proposed by different people on wireless communication based safety monitoring only environmental monitoring with few parameters with single wireless sensor node. For the successfully wireless data transmission has been increased interest in the Zigbee standard, in particular for an agent based wireless local positioning system with Zigbee technology is implemented, mainly for factory level applications. A cost effective Zigbee based wireless safety monitoring system with early-warning intelligence on temperature, radiation, flammable and poisonous gas and fire and smoke in hazardous area. With virtual instrumentation software, the safety system is obtained. With the test, the accident in the hazardous area can be found before the damage occurs. The industrial accident and environmental pollution is reduced more. The system can also provide a friendly human-machine interface. Additionally, it is convenient for the system maintenance and function expansion

II SYSTEM ARCHITECTURE

Based on requirements above, system architecture of the wireless sensor network for hazardous environmental monitoring is designed as Figure 1. The sensor network consists of a set of sensor nodes across the hazardous area, as ink node and a base station. Sensor nodes are designed to sense gas leaks, radiation, critical temperature, fire and smoke across the hazards field in this application. All infield sensory data are wirelessly transmitted into a sink node, which then sends them to the base station for data storing and analyzing using Zigbee protocol communications.

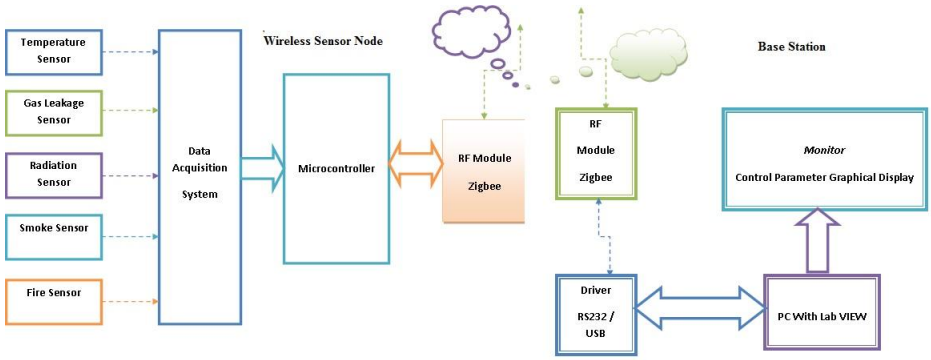
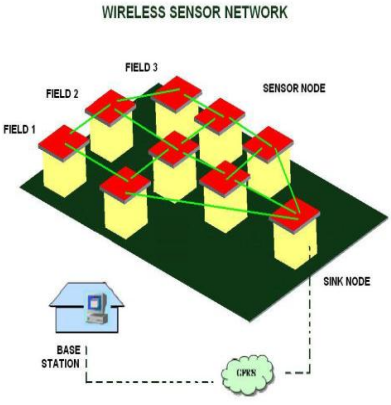


Figure 1: System Architecture

This research paper discusses the method of hazards safety monitoring system based on Zigbee communication with help of microcontroller MPS480 and RF module CC2500 apply SPI to implement the wireless exchange of information. The NS2 (Network Simulator) network simulation tool is used to test experiments. The paper reviews different aspects of Zigbee networks standard: protocol versions, network architecture routing and security. Ideas for improvement of Zigbee protocol are proposed, such as applying an additional routing algorithm compatible with the existing versions of Zigbee standard. Suggestions for improving Zigbee security architecture are also made. The research article explains the various problems encountered in surface mining and underground mining. Author has also mentioned on the efficient use of GPS in surface mining with the uses of RFID in underground mine and is elaborated in detail. The use of mobile objects in mine is also mentioned with the advantages Sensor node is developed based on the MSP430FG4618/F2013 module, an IEEE 802.15.4/Zigbee wireless microcontroller, which could provide a wide range of low cost solution for wireless sensor network applications.



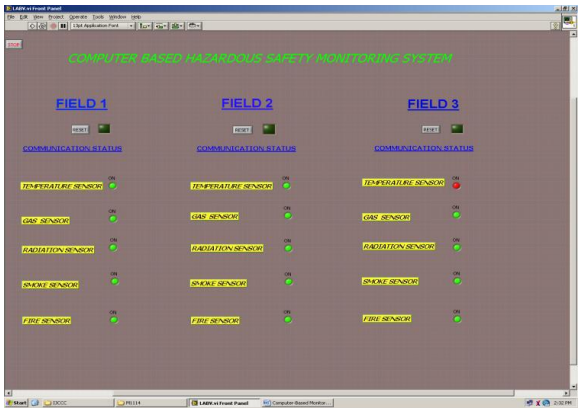


Figure 2: Wireless sensor Networks (WSN) Figure 3: Virtual Control using Lab VIEW

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A. Sink node

Sink node for aggregating and delivering sensor data of the whole network is designed based on CC2500, an embedded MPS480 controller module in order to meet future high-performance requirements. Sink node would be improved to connect weather sensors to monitor the local micrometeorological information in future design.

B. Network Protocol

In Zigbee network, there are three types node: coordinator, router and end device. All Zigbee networks must have one coordinator, which can select the frequency channel, start network, and allow other nodes to join it and other service. An end device and router are used to send and receive messages. Differently, a router can relay messages and allow the child nodes to connect to it. In our application, the network structure is designed cluster tree topology, which consists of a coordinator and a set of routers and end devices. A few sensor nodes are defined as the routers, while other sensor nodes are defined as end devices. In the future the sensor nodes acting as end devices would be powered by batteries instead of solar panels in order to optimize the design and reduce the cost.

C. Base Station

Base station is a host computer interfaced into RF Zigbee module with lab VIEW graphical programming. The management software running on the computer is designed to receive data real time from the sink node based on C/S model, through lab VIEW devolved virtual control system in computer shown in figure 3.The lab VIEW software has main functions as following.□ Data receiving As the server, listen the port and receive the data after accepting the authorized connection request. And then decode binary data string to obtain parameters according to custom defined data protocol.

- **Data storing:** Store and manage the data of in-field wireless sensor network based on the database. All the data are stored in table fields according to the sensing time and the sensor type.
- **Data analysis against time:** Read data from database table file and generate curves against time of all nodes for data analysis based on these sensor readings.

III SOFTWARE DESIGN AND IMPLEMENTATION

The system mainly consists of field sensors collection part and wireless communication module. The sensor collection part is mainly responsible for gathering the critical temperature, gas leakage, radiation, fire and smoke output acquisition from the internal and external industrial environment. The acquired signal after signal considering, compensation, the I-V circuit conversion, signal amplification and a series of operations will be sent directly to the communication module. Wireless communication module is responsible for sending the real-time data collected in the front of the sensor to Zigbee coordinator and then Zigbee coordinator deals with the data correspondingly, and the data is transmitted by Zigbee coordinator to host computer for display and wireless monitoring status on virtual environment using Lab VIEW software.

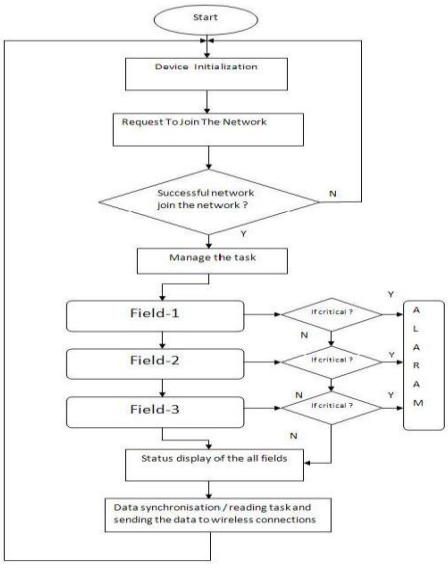

Figure 4: Software control using flow chart

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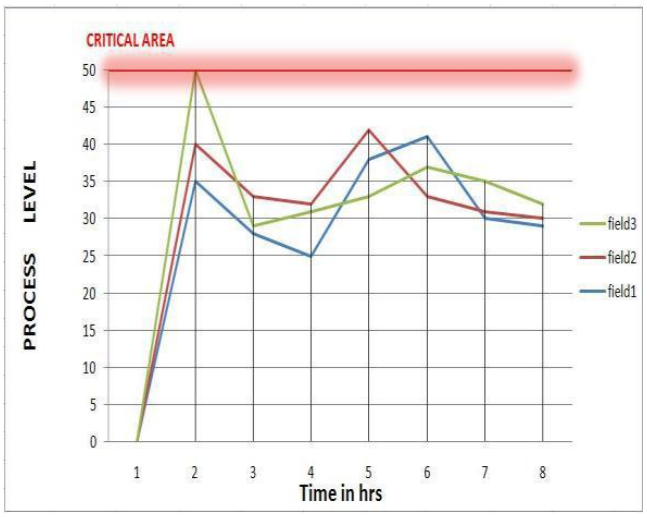
Software is the heart of the monitoring system, and hardware circuit can realize its function smoothly only under the correct guidance of the software. This system uses LabVIEW as development environment. The protocol stack achieves Zigbee alliance reference platform level, and is already widely adopted by global Zigbee developers at present. By testing the system's overall layout, it is known that the sensor module and coordinator module play a main role. Finally the information is transmitted from the coordinator to the control center and received and displayed by the computer in real time. The software control is shown in figure 3 processes defines the initialization of the devices in the system and sends the request to the coordinator to join the network. If the network joined successfully then it will go to the managing task in the system, if it is not success then it will again go to the device initialization and runs again. After the managing task, the three fields available in the system is requested and check the status of the each sensors and the status of the each fields are checked if these fields have any critical status such as the smoke, temperature, radiation etc then immediately the signal was send to alarm indication for safety. If there is no critical status, normally the field result is displayed and the data is synchronized and send to the wired and wireless connections in the network. Then it is again taken to the initial stage, this will repeat for every few seconds.

IV SIMULATION RESULT AND DISCUSSION

A. Performance Analysis

The critical temperature, gas leaks, radiation, fire and smoke conditions were recorded eight hours for the duration of experiment. A significant variation of the inside and outside industrial environment has been observed compared to critical measurement as shown in Figure 5. However, no significant trends have been observed for status. Then simulated values to reach critical observation to verify in during different times.



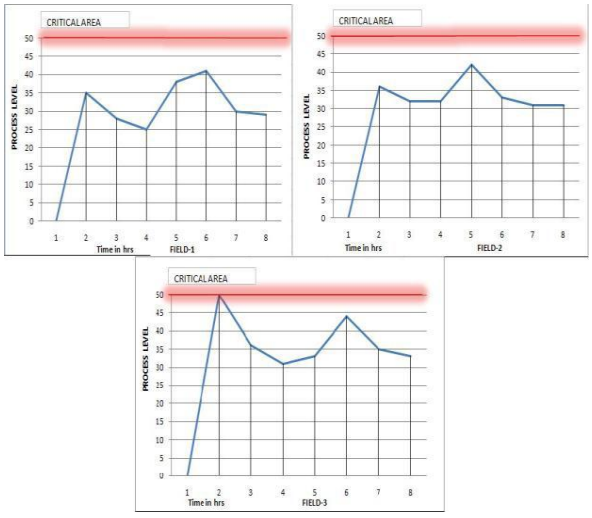


Figure 5: Performance analysis of critical field sensors Figure 6: Field Sensors critical analysis

A. Field Measurements Results

The three felid sensors were observed and exposed to the target analyses prior to deployment. The observed data of the field sensors are shown in figure 6. This indicates that the critical values are required to ensure that the parameter levels are reduced to a comfortable level. There is no significant influence of risk and critical changes. Safety and security trends are almost consistent throughout the experiments as shown in Figure 6.

V CONCLUSION

Traditional safety system can be effectively replaced by the wireless sensor network and virtual instrumentation system proposed in the paper. A larger industrial area and more hazardous area are now can be covered and potential accidents can be controlled efficiently. The system combined the low power; low cost Zigbee based high frequency wireless data transmission technology with computer controlled system. The sensor and Zigbee module can be preferably installed over the critical hazardous factors. Proper monitoring and conversation is possible between the work station and central station. In modern industry, virtual instrumentation based computer controlled system brings huge benefits to the regional economy. However, preparing for hazardous area safety is a critical factor for success. Through advanced technology, wireless sensors network with Zigbee communication based disaster prevention system offers the suitable features with the best stability and performance to help the hazardous safety to monitor all situations around its industrial

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environment. The system also can be easily extended with Zigbee wireless image transmission facility in future; it will improve scalability of hazardous environment and extend accurate position of industrial safety.

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